

injected beneath the epidermis of two caterpillars, and into a third the same quantity of distilled water. They were all swelled out, and suffered apparently from the distention, but equally, and in forty-eight hours were all equally recovered.

(Exp. 6.) Several caterpillars were subjected in various ways to the action of hydrocyanic acid, and all quickly died. From this it was proved that this caterpillar possesses no mithridate, no universal panacea against all poisons.

It may be fairly inferred, from the preceding experiments, that

(1.) The caterpillar of *Deiopeia pulchella* feeds on the virulent poison contained in the kernel of the seed of *Physostigma venenosum*; and that

(2.) This caterpillar is unaffected by the poisonous principle of the kernel—*eserinia*.

The bearing of the second result on our ideas of vital action should not be overlooked. A somewhat analogous case is furnished by the *Anthonomus druparum*, which feeds on the kernel of *Prunus cerasus**; and the poisonous properties of this kernel are well known to depend on the hydrocyanic acid it contains†. Here, then, our difficulties are increased: *Deiopeia pulchella* is unaffected by one poison, but is rapidly killed by hydrocyanic acid; and this latter occurs in the food of another insect, *Anthonomus druparum*. If life be “the sum total of the functions which resist death,” we have in these examples two organisms, each furnished with an exceptional potency of one or more of these death-repelling functions, or having bestowed on each, for a necessary purpose, a special, almost unrecognized, and certainly uninvestigated alexipharmic. Unfortunately, we have no knowledge of those intimate and primary structural changes which accompany every vital action, and our acquaintance with the perversions of such changes is quite as unsatisfactory.

Edinburgh University, April 1864.

XXXVIII.—On the Belgian Equivalents of the Upper and Lower Drift of the Eastern Counties. By S. V. WOOD, Jun.

IN describing the lower-Drift sands and gravels that occupy the counties of Norfolk and Suffolk, and of Essex north of Chelmsford, and which, at varying distances from the coast, pass under the Boulder-clay or upper Drift, and reappear at the surface from the denudation of the latter on the western side of

* A Manual of Entomology, translated from the German of Dr. Hermann Burmeister by W. E. Shuckard, M.E.S., 1836, p. 356.

† A Treatise on Poisons, by Robert Christison, M.D., &c. &c., 1845, p. 787.

Norfolk *, I showed that this lower Drift was but the deposit of a bay which, subsequent to the accumulation of the Red-Crag beds, advanced inland more by erosion than by depression. I also attempted to show that by the time this bay had thus reached, on the west, the western side of Suffolk, and on the south-west, the centre of Essex, a general submergence of the country terminated this accumulation of sands and gravels, and caused the precipitation, alike over those beds and over the older formations forming the terrestrial surface of the period, of the mud or clay that now occurs more or less continuously over so large a portion of the British islands, and is commonly known as the Boulder-clay. I also adverted to the probable great extension of this lower-Drift bay in an eastwardly direction over the north of Europe, from which direction the abundant pebbles of quartzite occurring in the gravels appear to have been derived.

My object is now to endeavour to show that in the Loess of Belgium and the Rhine we have the extension of the upper drift that in the British isles is represented by the Boulder-clay, and that in the Campinian sands, spread over all the north of Belgium, and enveloping beds of rolled stones, described by more than one continental geologist, we have the precise equivalent of the English sands and gravels described by me under the term "lower Drift."

The relationship of the Loess to the Boulder-clay seems to have attracted the attention of Sir Charles Lyell; for, in his memoir on the Belgian Tertiaries †, he observes:—"In regard to the relative ages of the loess and the northern drift with its erratics, the only positive information which I obtained during this tour was on crossing the Meuse from Maestricht to the right bank of that river, opposite the city. Here, in company with M. van Rymdyck, I observed that the sands of the Limburg tertiary series were covered by a bed of quartzose gravel with erratics, and this again by loess 30 feet thick. The locality alluded to is the tableland of Rassburg, near Geulem, which is about 300 feet above the Meuse, and about 450 feet above the level of the sea. The erratics are some of them very angular and more than 2 feet in diameter, consisting of quartzose slate, similar to that of the Ardennes, from which they are believed to have been transported. Such an instance of the superposition of loess to a certain class of erratics will not justify the conclusion that the origin of the loess generally was of later date than the northern drift. I should rather infer from the fact here mentioned, that the transportation by ice of large blocks was still going on when a part of the Belgian loess was deposited; in other words, the glacial epoch coincided,

* Ann. and Mag. of Nat. Hist. ser. 3. vol. xiii. p. 185.

† Quart. Journ. Geol. Soc. vol. viii. p. 281.

in part at least, with the epoch of the formation of the loess. I conceive that the more intense cold had passed away or receded northwards before the principal mass of the Loess was thrown down”*.

In his late work on the ‘Antiquity of Man’†, Sir Charles reverts very fully to the subject of the Loess; but he does not express any further opinion as to the relationship borne by it to the Boulder-clay, and seems disposed to correlate it with the *limon des plateaux* of the Somme Valley.

This superposition of the Loess to the Campinian sands enve-

* In the table annexed to the paper, Sir Charles places the Loess on the same horizon as the “Brick-earth and Drift” of England, and classes it as postpliocene or pleistocene. The Brick-earth, however, I regard as of later date than the Boulder-clay, being a formation deposited in the valleys which were formed by the forces that upheaved the bed of the Boulder-sea, when extensive denudations took place, by which not only the Boulder-clay, but the lower Tertiaries skirting the Thames Valley were denuded, the Brick-earth and associated gravels having afterwards been deposited on the denuded surfaces. The term Drift has been used to designate beds of so many distinct ages, that it is impossible to say, on a correlation of deposits, what precise meaning is to be attached to it. It has been used to designate not merely the boreal deposits accumulated before the valleys existing in the newer secondary and the tertiary strata were formed, but also those accumulated since the formation of the principal part of those valleys. The terms pleistocene (or postpliocene) and quarternary are equally the subjects of confusion, as both have been used in reference, not only to deposits newer than the valleys, but also to deposits, such as the Loess and Campinian sands, that are older than the valleys, and between which latter beds and the upper Tertiaries I believe no physical break whatever to exist. I have attempted to show (Phil. Mag. s.4. vol. xxvii. p. 180) that the whole of the valleys that in England exist in strata newer than the Trias originated in series of circular movements that elevated the bed of the Boulder-clay sea, and as to such of them as are south of the Thames, or immediately adjoin that river on the north, by the additional action of rectilinear movements that supervened on the circular; and I hope in a future communication to show the origin of the valleys in similar strata of North France and Belgium to be due to the same and other contemporaneous circular movements. In this respect I regard the great physical break, caused by these circular movements at the close of the glacial epoch, as a dividing horizon, above or below which the newer deposits of this area (although differing but little between themselves, as far as concerns their organic contents,) group themselves; for though in point of time the division between either group is insignificant, yet in point of change of surface arising from subterranean convulsion, all that took place over this area since the commencement of the Jurassic period is, I believe, as nothing in comparison with the complete break-up of the surface ensuing at the close of the glacial epoch. In referring, therefore, to a deposit as “drift,” except when quoting from others, I may be understood as referring to deposits older than the valleys formed by the circular movements; and it would, I conceive, tend to obviate confusion if the terms pleistocene, or postpliocene, and quarternary were in like manner confined to deposits newer than the valleys thus formed.

† London, 1863.

loping quartzite erratics, which seems to have induced Sir Charles to hesitate in referring it to the horizon of the Boulder-clay, and disposed him to place it as of somewhat later date, affords, however, to me the most satisfactory evidence that I can find of the absolute identity between the Boulder-clay and the Loess, as well as between the lower Drift of the Eastern counties and the Campinian sands of Belgium*.

The extension of the lower Drift over Essex and Suffolk, and the sharp though uninterrupted transition from it to the Boulder-clay, having been described by me in the paper before referred to, I cannot better show the position of the Campinian sands relatively to the Loess, and the extension of both of these deposits over Belgium, than by giving the substance of the description of M. d'Archiac in the 'Histoire des Progrès de Géologie.'

M. d'Archiac †, after referring to the "Geest," which he describes as underlying the turf-beds and marsh clays of Holland, as the only deposit in that country which, by its extent and continuity, seems to belong to an earlier epoch, and to be the result of a more general cause, quotes the description given by M. Elie de Beaumont of the "Geest," as a vast deposit of quartzose sand, sometimes slightly argillaceous, in a great part of which occur small erratics, consisting both of chalk flints and of fragments of crystalline rocks—a deposit occupying the surface all over the countries of Liège, Juliers, Brabant, Gueldre, Over Yssel, Westphalia, and Lower Saxony, forming extensive heaths, and reaching to the border of the sea or to the edge of the alluvial deposits of the low countries. M. d'Archiac then, after observing that the "Geest" attaches itself in Belgium to the *sables de Campine*, so widely spread in that country, hesitates to express any opinion as to the age of the deposit, by reason of the absence of sufficient evidence upon which one could be based; and he then proceeds with the description given by M. de Beaumont of the sands of North Germany, in which he indicates them as extending from North Germany westward without interruption past the Rhine, as far as the environs of

* With respect to the erratics underlying the Boulder-clay, it may prevent misapprehension if I observe that the terms upper and lower Drift, that I have adopted to distinguish respectively the Boulder-clay and the thick deposit of underlying sands and gravels, in no way represent the terms "upper and lower erratics" adopted by the late Mr. Trimmer. The lower erratics of that gentleman were the Boulder-clay (Quart. Journ. Geol. Soc. vol. vii. p. 21), and the upper erratics (*loc. cit.*) gravel-beds described by him as resting in places on the Boulder-clay. It would seem from the observations of Sir Charles Lyell, which I have quoted, that this order of succession weighed with him in forming an opinion as to the relationship between the Boulder-clay and the Loess.

† Vol. ii. pp. 141, 142.

Maestricht, and thence into the Campine of Belgium. Here, he adds, the sand of which the deposit is formed did not probably come from any great distance, being to all appearance derived from the degradation of the sands of the older Tertiaries, upon which it rests, both at Maestricht and in part of the Campine; while included in it are an abundance of flints, intermixed with a proportion of erratics, derived from the Ardennes and from the mountains skirting the Rhine.

In describing this deposit as covering the plateau of St. Peter's Mount at Maestricht, M. d'Archiac observes that its included erratics consist mostly of quartzites, of sizes varying from that of the fist to that of a walnut; and he adds that he regards the deposit as of the same age as the erratic beds, containing mammalian remains, which occur at the bottom of the valleys, and even on their sides, and on some of the surrounding plateaux, from the Rhine to the Channel, and which on the English side crown nearly all the chalk cliffs and detached tertiaries that overlie them.

Along the road from Tongres to Maestricht, adds M. d'Archiac, this diluvium disappears under another Drift-deposit of yellow sandy clay, true *Lehm* or *ancient alluvium* which envelopes the country like a mantle to a thickness of from eight to ten metres.

He then extracts from the 'Coup d'Œil sur la Géologie de la Belgique,' of M. d'Omalius d'Halloy, the description of that geologist, given in almost similar terms to those adopted by M. Elie de Beaumont,—the distinction between the overlying Loess or ancient alluvium, and the underlying sandy beds with erratics, being particularly shown.

Although, according to the view I take of the division that exists between deposits that are older and those that are newer than the valleys, there is in M. d'Archiac's identification of the Campinian sand with the gravels that cap the deposits along the coast of England a confusion of beds of different ages*, yet it is apparent from the description of the Belgian beds given by himself, as well as from those of the eminent geologists quoted by him, that the Campinian sands, with their associated and included beds of rolled stones, pass under the Loess, but are distinctly divided from it in the same manner as I have shown to be the case with the lower Drift and Boulder-clay. The elabo-

* The lower-Drift sands and gravels capping the Tertiaries of East Anglia, and which underlie the Boulder-clay, are, like that deposit, according to my views, older than the valleys; but the gravels and other accumulations of débris along the south coast, that sometimes cap the Chalk and sometimes the Tertiaries, are newer than the valleys of East Anglia, and even, as I believe, to a certain extent differ in age among themselves.

rate geological map of Belgium, by the late M. Dumont, indicates in a still clearer manner the area occupied by the Campinian sands and rolled stones, and by the overlying Loess, as well as the relative positions of the two beds* ; and in the following woodcut map I have reproduced, as well as the small scale will allow, the distribution of the two beds, as shown on the map of M. Dumont, adding to it the area of the eastern border of England, for the purpose of enabling a comparison to be made of the distribution and position there of the Boulder-clay (*h*) and underlying lower Drift (*g*), with the Loess and Campinian beds of the Continent. In Belgium the grouping of the two deposits shows that the valleys have been in some cases cut through the Loess down to the Campinian sands, where that deposit underlies the Loess, as, for instance, in the neighbourhood of Brussels and of Bilsen ; but in this respect the grouping of the beds is much less striking than in the case of the eastern counties of England. The coincidence between the valleys cut through the Loess and those of England, in point of time and mode of origin, is shown in a way that the limits of this paper do not permit me satisfactorily to enter upon. In the paper on the formation of the valleys, before referred to, I attempted to show that the valleys of the east of England, which cut through the upper and lower Drift of that region, resulted from the denudation having been regulated by the disturbance of the floor of the sea of the upper Drift, which took place in the form of a series of circular movements. The more important of these movements affecting that part of England originated in three centres, one of which was near Canterbury, another immediately south of the Isle of Wight, and another in the North Sea, off Flamborough Head †.

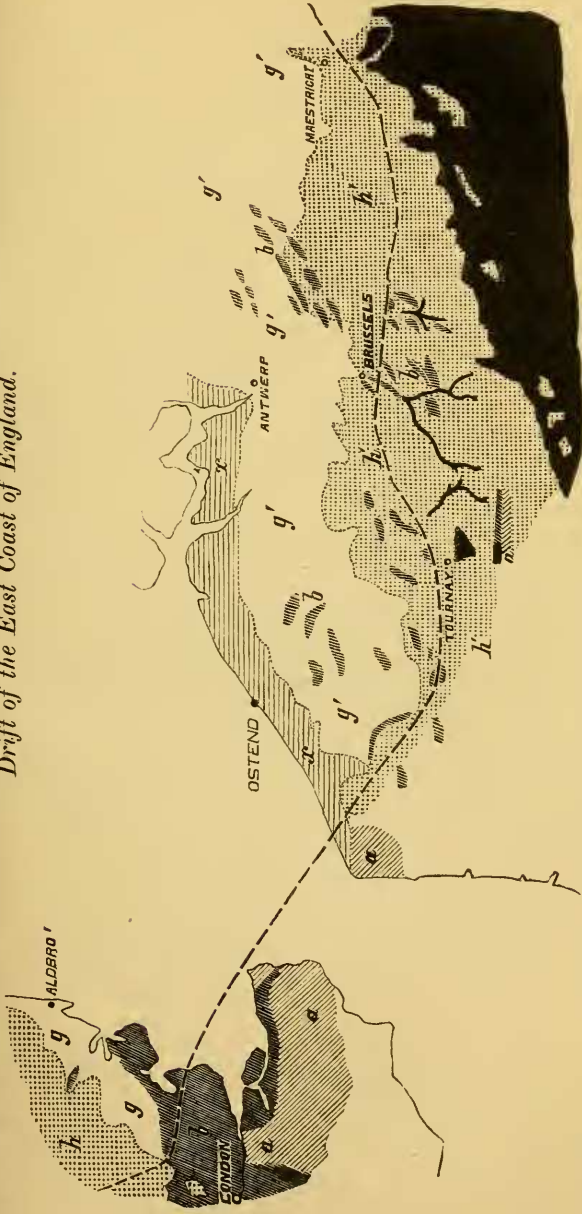
So far as I have been hitherto able to trace them, the circular movements emerging from these three centres, with others of similar character and simultaneous origin emerging from centres on the Continent, appear wholly to have formed the valleys which

* The three deposits are by him placed in the following descending order :

Loess (*limon Hesbayen*) ;
Sables Campiniens ;
Cailloux roulés.

† Although these three series form the principal valleys of this part of England, a close investigation of the Ordnance Sheets appears to disclose other inequalities of surface, that are parts of circles originating at much more remote centres, and whose effect has, from distance, become proportionately feeble. I hope at a future day to show the whole grouping of these circular phenomena, and the effect of their reciprocal pressure in France and Belgium, as well as in England, and the manner in which, in the south of this country, subsequent but more localized and powerful movements have supervened on them. The short notice of them published in the 'Phil. Mag.' is very incomplete, and in some respects imperfect.

Map showing the Distribution of the Loess and Campinian Sand of Belgium and of the Boulder-Clay and Lower Drift of the East Coast of England.



- a. Secondary.
 - b. Tertiaries older than the Red Crag.
 - x. Valley alluvium.
 - g. Lower Drift of England.
 - g'. Lower Drift of Belgium (sables Campiniens).
 - h. Boulder-clay.
 - h'. Limon Hesbayan (Loess).
- The black shading represents Palaeozoic or Metamorphic, overlain in parts by Loess.
The broken line indicates the supposed southerly limit of the lower-Drift bay.

cut through or exist in the Loess itself. If, therefore, the Boulder-clay or upper Drift of England has been acted upon by movements which have similarly affected the Loess of Belgium, it follows that both deposits had been thrown down before these movements began. It can be shown that these movements have not affected the postpliocene gravels that rest on surfaces from which the upper Drift has been denuded*, so that they must have originated prior to these gravels having been deposited; and since, from the great area over which the denudation has extended, we can attribute it to nothing but the action of the sea, we must assume either that it resulted during an emergence of the bed of the upper-Drift sea, or that a second general submergence and elevation took place. Although the evidence collected by geologists appears to me to indicate that parts of the south of England and of the north of France have been submerged (and that violently), and still further denuded, subsequently to the general disturbance and denudation produced by these circular phenomena, and subsequently to the area having been converted into land, yet there is no trace of any second *general* subsidence and elevation. It therefore seems to me that we have no alternative than to infer that these circular movements originated under the upper-Drift sea; and in that case, as the Loess is disturbed by those movements, it must have been deposited prior to the elevation of the bed of that sea.

In describing the lower Drift of the Eastern Counties, I dwelt upon the mode in which the position occupied by it relatively to the lower tertiaries indicated that the bay depositing it advanced inland by erosion as much as or more than by depression—differing entirely in this respect from the overlying Boulder-clay. The latter in the east of England, where not denuded, spreads evenly over the Eocene tertiaries which the lower Drift had not reached, and over the cretaceous and oolitic deposits where they come out from under the Eocene by original relationship of deposit. In this respect the Boulder-clay fully resembles the Loess, although in the eastern counties of England there were at the time of its deposit no eminences that, rising above the sea, escaped its envelope, as did the higher ridges of the Ardennes.

On the other hand, we have, in a section given by Sir Chas. Lyell in his paper on Belgium before referred to, a parallel, in the case of the Campinian sands, to the erosive action exerted by the sea of the lower Drift. The section is that at Dieghem, seven miles north-east of Brussels. Sir Charles describes sands at that

* The postpliocene gravels of the Thames valley have, however, been powerfully disturbed by the movements *subsequent* to those of the circular character.

place as lying upon the deeply eroded face of the Eocene tertiaries; but, being unfossiliferous, he does not identify them. A reference, however, on M. Dumont's map to the place where this section occurs leaves no doubt that the covering sands shown in the section are those mapped by M. Dumont as the *sables campiniens*. A short distance south of this place the sands pass beneath the Loess that, according to M. Dumont, caps the heights on either side of the valley at Brussels.

The precise margin of the lower-Drift bay, which, as I have shown, can be detected accurately at one part of Essex, appears to be obscured in Belgium beneath the Loess. By analogy and by assuming a uniformity of depression over either area to have taken place on the introduction of the upper Drift, we may infer that the margin of this bay in Belgium passed along the northern flank of the Ardennes, from which it derived the quartzites that constitute so considerable a proportion of its included pebbles, the Loess spreading over this margin and concealing it, as is the case with the western margin, that, in Essex, passes under and is hidden by the Boulder-clay.

In another section, given by Sir Charles Lyell, he shows the Loess at Tournay to rest upon the lower beds of the Eocene series, which there crop out, at their original margin of deposit, without (so far as the section represents) any intervening bed of sand or rolled stones. It would thus appear that the margin of the lower-Drift bay passed to the north of Tournay. In another section at Dileghem, two miles N.N.W. of Brussels, Sir Charles shows the Loess resting upon a bed of sand, which, although unfossiliferous, he refers, from similarity of appearance, to the same sands as those described by him at Cassel as belonging to the Diest group. The Diest sands, however, are not indicated by M. Dumont anywhere west or south of a point about ten miles north-east of Brussels—a still greater distance from Cassel. Dileghem, where this section occurs, is represented by M. Dumont as at the margin of the Loess and the Campinian sands, where the latter pass under the former. It would seem, therefore, that the unfossiliferous sands of Dileghem, upon which the Loess rests, belong to the Campinian series, the more especially so as we have seen that at Dieghem, a few miles only N.E. of the former place, the Campinian sands shown to occur there by M. Dumont agree with Sir Charles's section of that place. If, therefore, the Loess at Dileghem is underlain by the Campinian sands, the margin of the lower-Drift bay would pass somewhere between that place and Tournay; but if otherwise, it would pass between Dieghem and Dileghem. I, however, for the reasons stated, strongly incline to the former alternative, and I have adopted it in the hypothetical extension of the boundary given

in the woodcut map*. The great extent of the lower-Drift bay in the direction of the north of Germany, and even further still to the eastward, becomes, I think, demonstrable; but, as I observed in the description of the beds in the Eastern Counties ('Annals' for March 1864, p. 199), only a small portion of that bay impinged upon England. In the map accompanying that description, I did not draw the line indicating the probable boundary of the bay in England further north than the western side of Norfolk, in consequence of not having been able to make the necessary observations along that border to enable me to indicate the boundaries in that direction; I, however, believe that the boundary, after crossing the south-east of Lincolnshire, skirts the east of that county and runs northwards by Hull towards Bridlington; but for the present I defer any remark as to that extremity of the deposit.

The descriptions of M. d'Archiac, of the extension of the ancient diluvium over the north-east of France, do not enable one to form an opinion as to how far the conditions that prevailed during the Drift period on the northern side of the Ardennes existed also on the southern. It would seem from the descriptions of the French geologists, that the upper Drift (*i. e.* the Loess, or limon Hesbayen) occurs in the north-east provinces of France, south of the Ardennes; but to what extent, if at all, the lower-Drift beds may be there represented, these descriptions do not enable me to form any clear opinion. M. d'Archiac draws no distinction, such as I believe does exist, between gravels that are older than the valleys formed in the cretaceous and tertiary strata, and those that are newer than those valleys, as is evident from his identification of the Maestricht sand containing rolled quartzites (and which he describes as passing under the Loess towards Tongres) with the

* Sir Charles points out the difficulty of distinguishing between the sandy base of the Loess and the Eocene sands upon which it rests, by reason of the occurrence of a large number of derivative fossils in the former, washed out of the latter. This fully bears out the statement quoted from M. Elie de Beaumont, as to the source from which the Campinian sands have been supplied with their material. Sir Charles also instances cases in which M. Dumont, from this presence of derivative fossils, regarded as of Loess (Campinian) age beds which he (Sir Charles) was inclined to refer to the Eocene; and it would seem, from the grouping on M. Dumont's map of the Campinian and Loess beds, that this divergence of view is the cause of the discrepancy I have been discussing in the representations at Dileghem and Dieghem. As the Campinian beds thin out towards their margin, near the Ardennes, their distinction from the subjacent Eocene becomes probably more obscure than it is further to the north, where, from their greater thickness and from the presence of their included erratics, a general concurrence of opinion exists as to their existence beneath the Loess.

gravel-beds overlying the chalk, and also the detached Tertiaries on the English side of the British Channel—beds which I regard as wholly of newer date than the valleys, and consequently of newer date than either of the beds forming the subject of this paper. Of the lowermost of the latter beds, I have shown that its margin crossed the centre of Essex; but that portion of the upper Drift which in England is known as the Boulder-clay, I believe, originally extended continuously over the area south of the Thames, and was the more oceanic portion of that part of the upper Drift which formed the Loess of Belgium—and that the same formation spread over northern France. No remnant, however, of this upper bed, south of that at Muswell Hill, six miles north of London*, has, so far as is yet known, survived the denudation, which removed not only that bed, but large areas of the Eocene beds also; so that the gravel-deposits crowning the surface of the denuded Chalk and Tertiary on the English side of the Channel are in no way connected with either of the beds which form the subject of this paper.

In this uncertainty attending the spread of the upper Drift over France, I have not attempted to pursue the correlation of the deposits beyond Belgium; but it is apparent, from the views I take, that I regard the *limon des plateaux* which caps the chalk heights overlooking the valley of the Somme, and which Sir Charles Lyell seems inclined to refer to the Loess, as of a later date than that deposit, although I believe it to differ in age, as Sir Charles justly points out, from the deposits filling the Somme valley. According to my views, the whole mass of the Eocene tertiaries that spread from Mons en Pevèle, on the north, to Beauvais on the south, were denuded from the chalk forming the heights of the Somme, subsequent to the deposit of the Boulder-clay over those Tertiaries, and before this *limon des plateaux* had settled upon the surface of the chalk thus exposed.

The Boulder-clay of the east of England has hitherto, so far as

* Over the London Clay north of the Thames, and particularly over the south-east of Essex, stones occur not unfrequently on the surface of the soil, that never came from the wreck of the Eocene tertiaries, but well agree with those included in the Boulder-clay: these I believe to have come from that deposit, and, having escaped the transporting agencies in operation at the time of the denudation, to have settled on the denuded surface of the London Clay, and in that way now convey a faint indication of the former existence of the Boulder-clay over the area where they are distributed. A boulder of crystalline rock, water-worn, containing several cubic feet, exists at Grays, and another at Benfleet; but as they may possibly have been brought by ship, it would be unsafe to rely on them as evidence of the Boulder-clay having extended, as I believe it did extend, over those places.

I know, yielded no proper fossils, its included organic remains being wholly derivative*. In Belgium, the only fossils obtained from the Loess appear to be of fluviatile, or rather terrestrial habitat; and it is the presence of these latter, doubtless, that has chiefly contributed to deter geologists from referring the Loess to the horizon of the Boulder-clay. Speculations on the agencies producing these discordant features have not much to rest upon; but we may not unreasonably take into account the influence of the arctic conditions of the period as either causing or contributing to this result. The views of geologists have already been expressed in favour of a great freshwater discharge down the valley of the Rhine as the cause of the deposit of the Loess, although they have differed as to the mode in which the fresh water was distributed. It appears to me, however, that in the gorge of the Rhine we should, under arctic conditions, have one of those deep fiords, described by Dr. Sutherland† as so fertile in glacier production, that now indent Baffin's Bay, with the added condition of its being the outlet of the drainage of a considerable tract of land. If a great difference between the temperature of summer and that of winter prevailed during the Loess period, more resembling the climate at the mouth of the Mackenzie and Coppermine Rivers than those of the eastern side of America, very extensive floods of fresh water would be poured down the valley of the Rhine during summer, and spread over a considerable area at its mouth. Whether this periodical disturbance of the distribution of fresh and salt water over the region near the point of discharge would render the area unsuited alike for the habitation of marine, of fluvio-marine, and freshwater mollusks is uncertain: a better knowledge than is yet possessed of what now obtains, under circumstances presenting the nearest analogy at the present day, is required before a satisfactory reply can be given; but it has occurred to me as not improbable that, since the included Mollusca of the Loess are of that habitat that they may well have been carried down from swamps or rills existing high up the Rhenish country, or among the higher elevations of the Ardennes, and sparsely distributed with the muddy sediment over the Loess area, such a state of things might furnish an explanation of the absence of either fluvio-marine or of purely marine Mollusca. The intermittent volume of the freshwater discharge would, I conceive, produce conditions quite different from those ordinarily understood as fluvio-marine,

* I am permitted by Mr. J. G. Jeffreys to state that he has recently obtained marine molluscous remains from what he regards as undoubted Boulder-clay of the Yorkshire coast.

† Quart. Journ. Geol. Soc. vol. ix. p. 30.

which result from the regular and constant intermixture of the fresh water of rivers with the sea-water. This conjecture also receives some support from the circumstance that the included shells of the Loess appear to become rarer as the distance from the Rhine increases, and from the fact that the Hesbayan mud, argillaceous-sandy in Belgium, becomes on the extreme east of Suffolk more clayey, but yet less so than further to the west, and its included chalk débris are there but scanty; while as we go westward, and approach the region of the oolitic clays, from which so much of the argillaceous material of the Boulder-clay of the east of England has been derived, the clayey character of the deposit becomes more decided. Approaching the Chalk region, as well as over it, the extensive intermixture of chalk-detritus shows that the adjacent material largely contributed to the sediment, and that little or nothing was derived from the Hesbayan area. Over the Eastern Counties also the Boulder-clay is destitute, so far as hitherto observed, of fossils; so that it would seem to form a sort of neutral ground between the Loess with its included land-shells, and the Boulder-clay of the north with its deposits of marine shells.

I have not been able to find any description of the upper Crag of Antwerp calculated to throw any light on the relationship borne by that deposit to the Campinian sands, or showing whether the transition that exists in Suffolk between the Red Crag and the lower Drift obtains also in Belgium; and, indeed, it would seem that the level state of the country around Antwerp forms an obstacle to a satisfactory investigation of that question.

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In the paper on the "Red Crag and Drift" ('Annals,' March, p. 185) I observed, in reference to the passage-beds between the Red Crag and Drift, that I understood from Mr. Prestwich that he no longer adhered to the section of that place published by him in the Quart. Journ. Geol. Soc. (vol. v. p. 345). I, however, should have said that it was his *interpretation* of some parts of that section, and not the order of superposition, to which Mr. Prestwich does not now adhere. It will be seen, by a comparison of the two sections, that, in point of superposition, there is no material difference between them. It was in respect of the unconformability of these beds to the Red Crag that my views differed from those expressed by Mr. Prestwich in 1849.